

CLAIMS

1. An apparatus for feeding fuel which has fuel feeding means for feeding the fuel and combustion air supply means for supplying combustion air to a combustion area, said apparatus comprising:

5 mixing means for mixing the fuel of said fuel feeding means with combustion gas extracted from a furnace and/or steam of steam supply means; and

fuel gas introduction means for introducing a mixed fluid of said fuel and said combustion gas and/or steam into said combustion area as a fuel gas so as to
10 mix the fuel gas with said combustion air.

2. An apparatus as defined in claim 1, wherein said mixing means has a mixing area for mixing said fuel with said combustion gas and/or steam, and

the fuel and the combustion gas and/or steam are introduced into said mixing area for producing said fuel gas to be introduced into said combustion
15 area.

3. An apparatus as defined in claim 2, further comprising combustion gas cooling means for cooling said combustion gas and heating means for heating said combustion gas and/or steam, wherein said mixing area is positioned between said heating means and said combustion area.

20 4. An apparatus as defined in claim 2, further comprising combustion gas cooling means for cooling said combustion gas and heating means for heating said combustion gas and/or steam, wherein said mixing area is positioned between said cooling means and said heating means.

5. An apparatus as defined in one of claims 1 through 4, comprising forced
25 circulation means for inducing said combustion gas from said combustion area through combustion gas extraction means for extracting the combustion gas of the combustion area therefrom, wherein the forced circulation means adds said steam to said combustion gas and delivers the combustion gas to said mixing device under pressure.

6. An apparatus as defined in claim 3 or 4, wherein said cooling means and heating means are provided with a regenerator which is in heat transfer contact with said combustion gas at a high temperature so as to effect heat accumulation, and which is in heat transfer contact with said combustion gas and /or steam after
5 cooled so as to effect heat emission.

7. An apparatus as defined in one of claims 1 to 6, wherein said fuel feeding means is adapted to continuously feed said fuel to said mixing means.

8. An apparatus as defined in one of claims 1 to 6, comprising a plurality of said mixing means and passage change-over means for switching a fluid passage
10 of said combustion gas and/or steam leading to said mixing means, wherein said fuel feeding means is provided with fuel control means for switching a fuel supply passage in synchronism with said change-over means.

9. An apparatus as defined in claim 1 or 2, further comprising steam heating means for heating steam of said steam supply means up to a temperature equal to
15 or higher than 700 deg. C and feeding the heated steam to said mixing means.

10. An apparatus as defined in claim 2, wherein said fuel gas introduction means has a fuel gas injection port opening to the combustion area, and said mixing area is positioned within the fuel gas injection port to be in communication with said combustion area.

20 11. A combustion system comprising said apparatus as defined in one of claims 1 through 10, and combustion air supply means for feeding the combustion air to the combustion area.

12. A combustion system as defined in claim 11, comprising mixing means for partially feeding said combustion gas and/or steam to said combustion air supply
25 means and mixing the combustion gas and/or steam with the combustion air.

13. A combustion system as defined in claim 11 or 12, wherein said combustion air supply means has combustion gas exhaust means for exhausting the combustion gas of said combustion area, and a regenerator which is in heat transfer contact with the combustion gas to take a heat accumulation action and
30 which is in heat transfer contact with the combustion air to take a heat emission

action, and wherein said combustion air is pre-heated up to a high-temperature equal to or higher than 700 deg. C.

14. A method for feeding fuel in which the fuel and combustion air is fed to a combustion area, said method comprising:

5 feeding combustion gas extracted from a furnace and/or steam of steam supply means to a mixing area;

feeding said fuel to said mixing area to produce a mixed fluid of the fuel and said combustion gas and/or steam; and

10 introducing said mixed fluid into said combustion area as a fuel gas so as to mix the fuel gas with the combustion air, thereby causing a combustion reaction of said fuel gas in said combustion area.

15 15. A method as defined in claim 14, wherein said combustion gas extracted from the furnaces at a high temperature and/or said steam heated up to a high temperature equal to or higher than 700 deg. C by steam heating means is introduced into said mixing area to be mixed with said fuel.

16. A method as defined in claim 14, wherein the fuel is mixed with said combustion gas and/or steam after the combustion gas and/or steam is heated up to a high temperature equal to or higher than 700 deg. C.

20 17. A method as defined in claim 14, wherein said mixed fluid is heated up to a high temperature equal to or higher than 700 deg. C after the fuel is mixed with the combustion gas and/or steam.

25 18. A method as defined in one of claims 14 to 17, wherein a part of said combustion gas and/or steam is mixed with said combustion air to reduce an oxygen density of the combustion air, and then, said fuel gas is mixed with the combustion air.

19. A method as defined in one of claims 14 to 18, wherein said steam is added to said combustion gas to adjust a quantity of steam contained in the combustion gas.

20. A method as defined in one of claims 15 to 17, wherein said combustion gas, said steam and said mixed fluid gain sensible heat which the combustion gas loses upon cooling thereof, so as to be reheated or heated.

21. A method as defined in one of claims 14 to 20, wherein said mixing area of said fuel and said combustion gas and/or steam leads to said combustion area, and said fuel and said combustion gas and/or steam are injected into said mixing area respectively, so that the mixed fluid in the mixing area is introduced into the combustion area as said fuel gas.

22. A method as defined in one of claims 14 to 21, wherein said mixed fluid introduced into said combustion area has a temperature equal to or higher than 700 deg. C.

23. A method as defined in one of claims 14 to 22, wherein said mixed fluid introduced into said combustion area is mixed with said combustion air pre-heated up to a temperature equal to or higher than 700 deg. C.

24. A method as defined in one of claims 14 to 23, wherein said combustion gas has an oxygen density equal to or smaller than 10%.

25. A method as defined in one of claims 14 to 24, wherein a mixing ratio of said combustion gas and/or steam with said fuel is set to be in a range of 1:1 ~ 20:1.

26. A method as defined in one of claims 14 to 25, wherein a mixing ratio of said fuel gas and/or steam with said combustion air is set to be in a range of 1:10 ~ 20:10.

27. A method as defined in one of claims 14 to 26, wherein a velocity of flow of said fuel gas entering said combustion area is set to be in a range between 10m/s and 150m/s.

28. A combustion method including said method for feeding fuel as defined in one of claims 14 to 27, wherein said mixed fluid is introduced into said combustion area as the fuel gas, and the fuel gas is mixed with said combustion air to cause a combustion reaction of said fuel gas in said combustion area.

29. A heating apparatus comprising said combustion system as defined in one of claims 11 to 13.

30. A heating apparatus as defined in claim 29, comprising an auxiliary combustion device for introducing said combustion air and said fuel into said combustion area during a cold period.

31. A heating apparatus as defined in claim 29 or 30, wherein said fuel gas introduction means introduces the fuel gas flow into said combustion area in parallel with the combustion air flow.

32. A heating apparatus as defined in claim 29 or 30, wherein said fuel gas introduction means introduces the fuel gas flow into said combustion area in a direction intersecting a direction of said combustion air flow.

33. A heating apparatus as defined in claim 29 or 30, wherein said fuel gas introduction means introduces the fuel gas flow into said combustion area in a direction opposite against the combustion air flow.

34. A heating apparatus as defined in one of claims 29 to 33, which constitutes one of a tubular furnace, metal heating furnace, ceramic industrial kiln, metal melting furnace, gasification melting furnace, boiler and radiant tube.

35. A heating method wherein a subject to be heated is heated by flame which is produced by said combustion method as defined in claim 28.

36. A heating method as defined in claim 35, wherein said subject to be heated is defined by a plurality of heated segments and said flame is generated between said segments.

37. A heating method as defined in claim 35 or 36, wherein said fuel gas is introduced from a substantially constant position into said combustion area and said combustion air is introduced from a substantially constant position into said combustion area.

38. A heating method as defined in claim 35 or 36, wherein a position in which said fuel gas is introduced into said combustion area and a position in which said

combustion air is introduced into said combustion area are changed in a predetermined interval of time.

39. A heating method as defined in one of claims 35 to 38, wherein said fuel is mixed with said combustion air in a cold period so that a temperature of the combustion area is raised by an exothermic combustion reaction of said fuel and said combustion air.

40. A heating method as defined in one of claims 35 to 39, wherein flame produced by said fuel gas and said combustion air is directly in contact with the subject to be heated.

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